Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (ATSA SURF IA) Operational Services and Environment Description

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Working Group 1
Sub Group ATSA SURF IA

This is not the final version of the document and has not been approved by the SC 186-plenary committee

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Abstract

This document describes Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (ATSA SURF[1] IA) about traffic related safety hazards. ATSA SURF Indications are intended to facilitate pilot awareness by identifying the runway traffic status as relevant to ownship operations under normal operational conditions. ATSA SURF Alerts are intended to attract the attention of the flight crew to a non-normal traffic condition and to facilitate a timely response. The document describes the concept, roles, responsibilities, and functional requirements for ATSA SURF IA. The described application is currently in a draft stage of a consensus based definition process that includes government and industry stakeholder organizations as part of RTCA, SC-186, Working Group 1. The objective is the development of requirements and guidelines for universal flight deck-based alerting and indication of actual or potential traffic conflicts to avoid surface and near surface traffic collision hazards for general aviation and commercial operators.

The described application builds on and extends existing application descriptions. Specifically, the Airport Surface Situational Awareness (ASSA) and Final Approach and Runway Occupancy Awareness (FAROA) applications (RTCA / DO-289) that contain requirements for electronic maps and traffic displays are basic building blocks. The described application is intended for implementation in the relative short term over a few years but also considers later development phases.

[1] ATSA SURF is the name of an application description that is currently being defined by the Requirement Focus Group (RFG), an international body consisting of members from RTCA, FAA, Eurocontrol, and EUROCAE. The ATSA SURF IA application builds on the ATSA SURF application description.

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1 Introduction

This document describes Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts (ATSA SURF IA) about traffic related safety hazards. The document is intended as an addendum to existing RTCA document DO-289 (RTCA 2003) where the application of ADS-B for the display of traffic information on cockpit displays is described. A cockpit display of traffic information (CDTI) is assumed part of this application[2]. The baseline version of this application does not require specific airport ground infrastructure but will utilize a ground infrastructure that provides ADS-B position reports. While remaining technologically independent of ground based indication and alerting systems, the alerting logic employed will remain compatible with ground based or hybrid systems. Future versions of this application may integrate the uplink of ground-based information other than surveillance information. Implementation alternatives that were excluded from this initial version are listed in Section 7.

1.1 Background

Airport surface operations include the movement of aircraft and ground vehicles such as snow plows or personnel transport vehicles. At airports with air traffic control (ATC) towers, traffic movement in the active movement areas around taxiways and runways are controlled by ATC during hours of operations. Airport surface movement in non-movement areas, (e.g. around ramp areas that are close to the airport terminal) may be controlled by airline operated ramp towers that provide control from the gate to the active movement area. At non-towered airports, pilots coordinate airport and runway usage via radio communication among themselves, with fixed based operators, and airport operations personnel as appropriate.

During current airport surface operations, flight crews navigate the airport surface via their self-determined or ATC assigned taxi route. They use out-the window visual aids, paper charts, and possibly electronic map displays to support their navigation. Taxi route information is communicated verbally to flight crews via radio. Out-the-window visual aids on runways and taxiways include centerlines, edge lines, airport surface lights and signage, other aircraft and vehicles, terrain, buildings, taxiways, runways, and so on.

Runway incursions at towered airports in the United States (US) have been a major area of concern for the U.S. National Airspace System (NAS) for the past decades. ICAO and FAA both define a runway incursion as any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and take-off of aircraft (FAA 2008). The NAS has approximately 500 Federal Aviation Administration (FAA)/contract towered airports that handle about 170,000 operations per day. From FY 2004 through FY 2007, there were approximately 250 million operations on towered airports. During these operations, there were 1,353 runway incursions—an average of one runway incursion per 183,621 operations during the four-year period. (FAA, 2008).

In the US, the FAA has initiated several initiatives to increase runway safety:

- Standards for airport surface markings have been updated to improve markings in the hold-short environment (FAA Advisory Circular – AC 150/5340-1J, FAA, 2006a).

[2] Considerations for non-CDTI implementations will be part of future versions of this document.

- A runway status light system has been developed to provide pilots with information about current or immediately anticipated runway occupancy (FAA 2007a). The runway status light system consists of runway entrance lights (REL) for the runway entrance and take-off hold lights (THL) for take-off situations. That system has been demonstrated at Dallas Fort Worth International Airport (DFW) and at San Diego-Lindbergh Field (SAN).
- The Airport Movement Area Safety System (AMASS) has been developed to provide air traffic controllers with alerts about potential collisions between aircraft (FAA 2005b). The system has encountered some limitations in usability under certain conditions that are also due to the ground surveillance technology. A new system has been developed to address some of these limitations, see below.
- The Airport Surface Detection Equipment, model X (ASDE-X) was developed to provide an electronic display of aircraft movement and safety alerting functionality to the air traffic control tower and replace some of the ASDE3/AMASS systems (FAA 2006b). This system is projected to be deployed at 35 airports and is intended to provide situation awareness and alerting functions to air traffic controllers.
- New airport designs are directed to reduce the likelihood of creating areas that could cause runway incursions. This is done by, for example, reducing large expanses of concrete and by reducing the number of runway crossings which have been large contributors to runway incursions.
- Similarly, some airports are retrofitted with end around taxiways (EAT) to allow aircraft to taxi around runways instead of crossing them.
- The FAA has initiated a Runway Incursion Information Evaluation Program (RIIEP) to learn more about runway safety hazards. This program provides pilots who are involved in runway incursions some protection against legal action if they provide information to aviation safety inspectors.
- Flight decks have started to be equipped with moving maps. Also, standards for the CDTI are currently being developed. CDTI's have so far been limited to situation awareness enhancing functionality. New designs such as the application described in this document are addressing this limitation.
- The FAA is providing guidance to airlines about standardizing ground operations in AC 120-74A (FAA, 2003a) for flight crews and in AC 91-73 (FAA, 2003b) for single pilot operations.
- FAA and pilot associations are providing training and education about runway safety to pilots in various formats including workshops, websites, and DVDs.

International efforts to increase runway safety include the development of an Advanced Surface Movement Control Guidance System (A-SMCGS) that provides surface traffic management, guidance, and alerting functionality to ATC and pilots (see IFATCA 2003). Thereby, European countries have focused on alert implementations for controllers whereas alerting for the flight deck has not yet been defined in much detail.

Despite these efforts, runway incursions have continued to occur and incursion rates have remained essentially constant. The National Transportation Safety Board (NTSB) has recommended the development of a ground movement safety system with direct pilot warning capabilities (NTSB 2000). The recommendation states:

> *Require, at all airports with scheduled passenger service, a ground movement*

> *safety system that will prevent runway incursions; the system should provide a direct warning capability to flight crews. In addition, demonstrate through computer simulations or other means that the system will, in fact, prevent incursions. (A-00-66 2000).*

There is general agreement that the main causal factors contributing to runway incursions are related to human behavior (e.g., Cardosi & Yost, 2001; FAA 1998). Specifically, Adam & Kelley (1996) surveyed 1437 pilots from two commercial airlines and interviewed a subgroup of them to identify causal factors for runway incursions (see also Adam, Kelley & Steinbacher, 1994). Causal factors are related to airport characteristics such as signage, markings, lighting, runway geometry, lack of familiarity of pilots with the airport surface and procedures. Causal factors are also related to the communication of control clearances via auditory communication channel which can quickly result in information bottlenecks under high traffic density. Errors can be caused by both pilots, controllers (see e.g., Bales, Gillan & King, 1989 and Steinbacher, 1991), or surface vehicle operators.

The causal factors leading to runway incursions and collisions are addressed in multiple ways. The application that is described in this document intends to (1) to facilitate the perception of runway safety relevant traffic information by pilots, (2) to increase the likelihood that runway safety relevant traffic information is appropriately processed, and (3), to facilitate an appropriate compensatory response once an error has occurred.

1.2 Operational purpose

The operational purpose of the ATSA SURF IA application is to help decrease the occurrence of runway incursions or collisions on or near the airport surface. ATSA SURF IA addresses actual or potential high speed conflicts on or near runways using traffic surveillance information such as ADS-B.

The ATSA SURF IA application builds on existing application descriptions that are described in RTCA document DO-289 (RTCA, 2003). The Airport Surface Situational Awareness (ASSA) application is a flight deck-based application for the depiction of ownship position and traffic positions on a surface moving map that includes runways, taxiways, holding areas, ramps, hangars, and prominent airport features. The ASSA application may be hosted on a multifunctional display, a head-up display, or an electronic flight bag display. The flight crew may use this display to identify traffic positions relative to ownship and may observe traffic movement in addition to out the window observations.

Also described in DO-289 (RTCA, 2003) is the Final Approach and Runway Occupancy Awareness (FAROA), an application that provides information about runway occupancy to the flight crew while on approach and is a subset of the ASSA application (RTCA 2003, F.2.1.1). The FAROA application displays only the runway layout without other airport layout details such as taxiways or ramp areas. Neither the ASSA nor the FAROA applications provide active alerts to pilots. Both applications, ASSA and FAROA have been incorporated into an international application by the Requirement Focus Group (RFG). That concept has been named the ATSA SURF concept (RFG 2006). ATSA SURF IA adds two distinct components to the ATSA SURF application. First, runway occupancy and relevant traffic is indicated when it relates to runway safety under normal operational conditions. Second, alerts are displayed for non-normal operational conditions to facilitate immediate flight crew awareness and subsequent timely response.

Flight crews will use ATSA SURF indications and alerts in combination with other information inside or outside the cockpit to obtain traffic situation awareness and determine the appropriate course of action. In addition, ATSA SURF alerts are designed to be sufficient for an immediate flight crew response and may be used as sole means for response initiation. In this sense the ATSA SURF IA application goes beyond a pure situational awareness application and requires alerting algorithms.

1.3 Domain / Environment

The ATSA SURF IA application will be available at all airports with a suitable[3] airport database and not require specific airport ground infrastructure. It will utilize a ground infrastructure that provides ADS-B position reports. The ATSA SURF IA application is expected to be utilized by all types of aircraft and surface vehicles operating in the NAS (e.g. including military, general aviation, commercial carriers) at both controlled as well as uncontrolled airports. The covered volume of airspace includes approach and departure zones up to the altitude of approximately 1000 feet above surface where existing collision avoidance systems such as TCAS do not provide resolution advisories. ATSA SURF IAs are provided only for traffic on runways, not on taxiways or ramp areas. The application will include available data including air-to-air ADS-B and ground-to-air TIS-B data. The ATSA SURF IA application provides indications and alerting under all visibility and weather conditions. Integration of ATSA SURF IA with existing cockpit alerting systems will be determined according to cockpit specific principles that may vary between aircraft types. Ground-based alerting capabilities such as AMASS, may in some situations provide different alerts than ATSA SURF alerts. It is foreseen that ATSA SURF alerts are provided later than ground-based alerts to minimize interference. ATSA SURF indications as outlined in this document resemble RWSL indications of runway occupancy. Slight differences of RWSL onset and ATSA SURF indication onset are expectable. Interoperability assessments are required to confirm consistency between ATSA SURF indications and other ground based alerting and indication systems. As under current operations, voice communication between pilots and controllers will be used to resolve differences in available information between flight-deck and ground.

1.4 Maturity and user interest

As runway safety is of continuing high priority in the NAS, a flight deck-based airport surface safety system is expected to reduce the likelihood of runway collisions and is of high interest to the aviation community. Such a capability has been recommended by the NTSB in its most wanted recommendations for the FAA. The recommendation has been quoted above. Also, the FAA has initiated ADS-B implementation to provide ADS-B services in the NAS starting at around 2010. Various research and development activities on flight deck-based airport surface safety systems have been conducted, e.g. Jones (2002, 2005), Jones and Prinzel (2006), Jones, Quach, Young, (2001), Young & Jones (2000), Cassell, Evers, Esche, & Sleep (2002, 2003), Hyer (2002), Hooey, Foyle, & Andre (2000), Hooey, Foyle, Andre & Parke (2000), Young & Jones (2001). For implementation of a flight deck-based airport surface safety system, the definition of a generally accepted standard is now needed.

[3] A suitable airport database contains the needed airport layout, signage, and marking information at an appropriate level of accuracy to support the ATSA SURF IA application.

2 Operational concept, roles, and procedures

2.1. Concept description

This section describes the concept of operations for the generation of ATSA SURF IA indications and alerts to the flight deck.

ATSA SURF IA's are intended to enhance flight crew traffic awareness and to avoid actual and potential high speed conflicts on or near the airport surface. The terms alerts and indications are defined in Section 8 and are consistent with regulatory guidance (see draft AC 25.1322, FAA, 2007c).

The ATSA SURF IA application provides traffic related indications and alerts respectively for different types of normal and non-normal scenarios associated with potential or actual runway conflicts. The term "scenario" is here used to describe a sequence of aircraft movement between at least two aircraft[4]. Scenarios are "conflict scenarios" if the movement between two aircraft/vehicles could potentially lead to a high speed collision. Five different types of aircraft movement are differentiated in the context of runway safety scenarios:

- Entering or crossing the runway: An aircraft or vehicle is moving toward the runway, is anticipated to potentially enter the runway, and therefore is causing an actual or potential conflict with ownship.
- Departure: An aircraft is departing, moving at a speed above taxi speed, e.g., 35[5] knots[6] and therefore is causing an actual or potential conflict with ownship.
- Approach to runway: An aircraft is lined up with the arrival runway and at a given time or distance from the arrival threshold (e.g. up to 3 NM) and has not yet touched down and is causing an actual or potential conflict with ownship.
- Landing: An aircraft has touched down and is rolling out and moving at a speed above taxi speed, e.g., 35 knots and therefore is causing an actual or potential conflict with ownship
- Stopped or taxiing on runway: An aircraft or vehicle is currently on a runway in a low energy state, i.e., either stopped or taxiing and therefore is causing an actual or potential conflict with ownship.

These aircraft states can occur on following set of runway constellations:

- Same runway
- Closely spaced parallel runway[7]
- Intersecting runways (or extended centerline intersection)

[4] Though vehicles are not specifically mentioned here, vehicles could also cause these conflicts.
[5] The indicated speeds are examples and should be harmonized with other systems that are utilizing ground speed to differentiate between aircraft states such as AMASS, ASDE-X, or the runway status light system.also, speeds may be different for different types of aircraft (e.g. jet versus prop)
[6] Departure mode may be determined using aircraft speed or other means, e.g. throttle position, if available.
[7] Closely spaced parallel runways are included here because movement on such runways can lead very quickly to a runway incursion scenario. For example, a landed aircraft may turn quickly off from one runway and inadvertently cross a closely spaced parallel runway.

From combinations of these two-aircraft movements and runway constellations, 20 runway conflict scenarios are derived[8]:

Type I Runway Incursion Scenarios: **Ownship taxies toward runway to enter runway**, and

1. Conflict traffic: approaches, lands, and taxies or stops on same runway
2. Conflict traffic: taxies to enter same runway, enters the runway, then departs
3. Conflict traffic is either approaching, landing, departing, or taxiing on intersecting runway
4. Conflict traffic is either approaching, landing, departing, or taxiing on parallel runway

Type II Runway Incursion Scenarios: **Ownship departs**, and

5. Conflict traffic: taxies to enter same runway or is stopped /taxiing on the same runway, and then departs from same runway
6. Conflict traffic: approaches, lands, taxies and then stops on runway
7. Conflict traffic is either approaching, landing, departing, or taxiing on intersecting runway
8. Conflict traffic is either approaching, landing, departing, or taxiing on parallel runway

Type III Runway Incursion Scenarios: **Ownship approaches runway**, and

9. Conflict traffic: taxies to enter same runway or is stopped /taxiing on the same runway and then departs from same runway
10. Conflict traffic: approaches, lands, taxies and then stops on runway
11. Conflict traffic is either approaching, landing, departing, or taxiing on intersecting runway
12. Conflict traffic is either approaching, landing, departing, or taxiing on parallel runway

Type IV Runway Incursion Scenarios: **Ownship has landed on runway**:

13. Conflict traffic: taxies to enter same runway or is stopped /taxiing on the same runway, and then departs from same runway
14. Conflict traffic: approaches, lands, taxies and then stops on runway
15. Conflict traffic is either approaching, landing, departing, or taxiing on intersecting runway
16. Conflict traffic is either approaching, landing, departing, or taxiing on parallel runway

Type V Runway Incursion Scenarios: **Ownship has stopped or is taxiing on runway**

17. Conflict traffic: taxies to enter same runway or is stopped /taxiing on the same runway, and then departs from same runway
18. Conflict traffic: approaches, lands, taxies and then stops on runway
19. Conflict traffic is either approaching, landing, departing, or taxiing on intersecting runway
20. Conflict traffic is either approaching, landing, departing, or taxiing on parallel runway

ATSA SURF IA indications, alerts or both may be triggered for these runway safety scenarios.

Next the principles for the presentation of ATSA SURF IA are described. The ATSA SURF indication and alert principles are guiding rules concerning safety relevant information in the flight deck relative to the ownship position and surrounding traffic. Presentation requirements are indicated in Table 3.

[8] The term conflict traffic in this list refers to traffic that is either in actual or potential conflict with ownship.

2.1.1. Principles for the Presentation of Indications and Alerts

ATSA SURF indications and alerts are provided as a supplement to surface traffic displays about a subset of "relevant traffic[9]". Figure 1 shows graphically the relationship between the different types of traffic. The largest circle represents all traffic on the airport surface. A subset of that traffic is relevant traffic, and a further subset of relevant traffic is either primarily are secondarily indicated traffic. An even smaller subset of relevant traffic is alerted traffic.

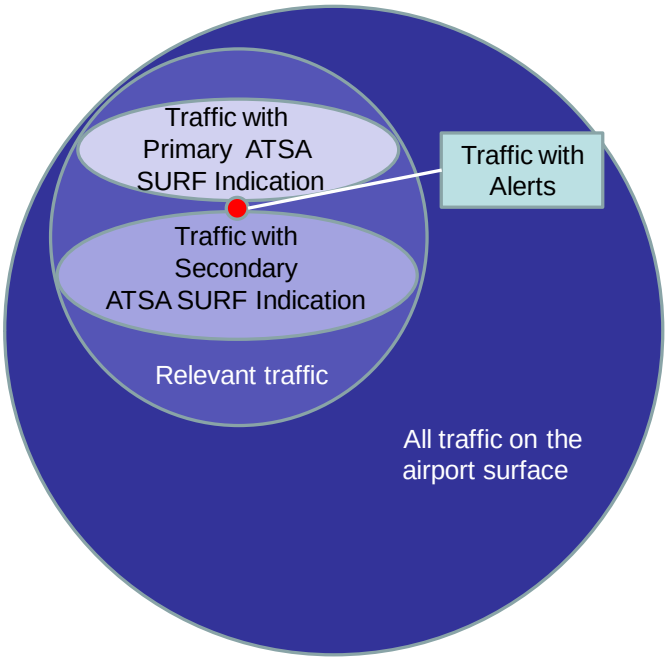


Figure 1 Schematic Depiction of Relation between Traffic Relevance and Indications and Alerts (not drawn to scale).

2.1.1.1 Indication Principles

ATSA SURF indications consist of highlighted, or in other means emphasized relevant traffic and runways on a CDTI when the conflict traffic is either on the runway, entering the runway environment, or is on approach to a runway. ATSA SURF indications facilitate pilot awareness and assessment of the situation by identifying current and immediately future runway and traffic status as relevant to ownship operations. Indications identify normal operational conditions to the flight crew that are generally relevant for runway safety but could be a precursor to a runway safety hazard. Indications are presented based on distance between ownship and runway or aircraft/vehicle and runway. This reflects the need for indications to be useable and expectable under normal operational conditions with which distance was found to be more consistent.

Two types of ATSA SURF indications are differentiated:

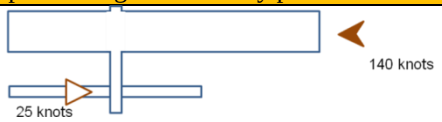
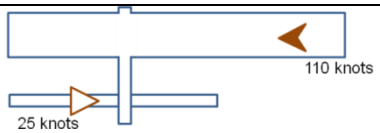
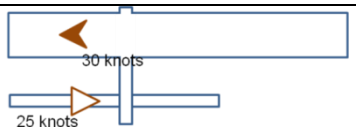
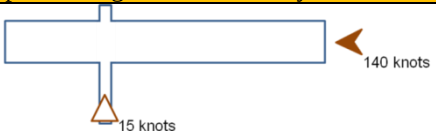
[9] Traffic that is viewed from ownship's current state is "relevant" if that traffic position, orientation, and movement leads to or could potentially lead to a runway incursion or collision within a foreseeable period of time. A "foreseeable period of time" (such as 90 sec or less for a landing aircraft) means here that ownship or traffic could initiate an action such as a turn or entry on a runway, continued taxiing, remain on the runway, departure roll initiation, or landing) that could directly lead to a collision hazard. In addition, traffic is "relevant" if it facilitates the flight crew's perception and understanding of the current traffic situation (e.g. traffic on ownship's runway) . Relevant traffic must be displayed on a CDTI. However, not all relevant traffic may be ATSA SURF IA indicated.

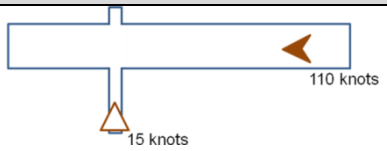
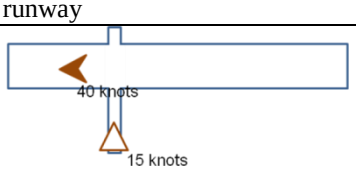
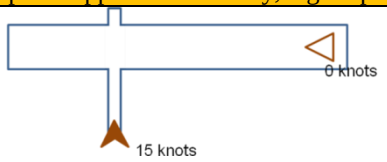
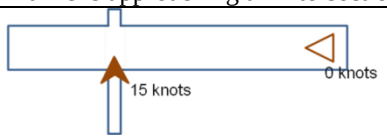
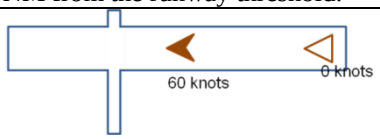
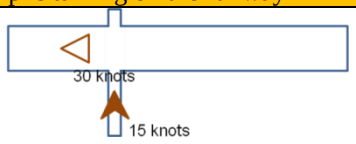
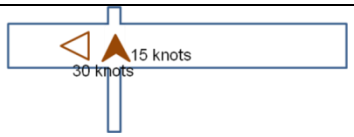
Primary indications are provided if ownship's runway is not usable for taxi, takeoff or landing by ownship. A collision hazard would result if ownship were to use that runway when encountering a primary indication.
Before proceeding with taxi, take-off, or landing, the crew should ensure that they have the appropriate clearance and that the indicated traffic is no factor. If ownship were already on that runway when a primary indication appears, it should not initiate departure. If ownship were approaching to land on that runway, the flight crew should monitor the traffic to facilitate a decision about initiating ATC communication or a go-around at the appropriate time.

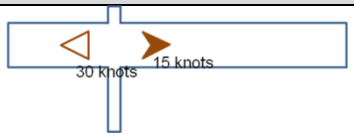
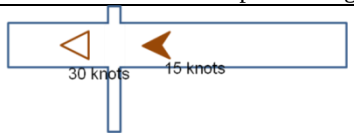
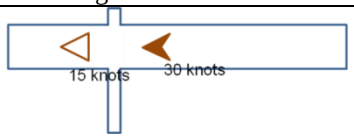
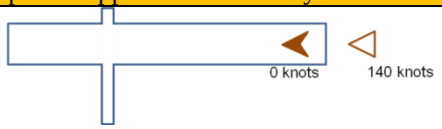
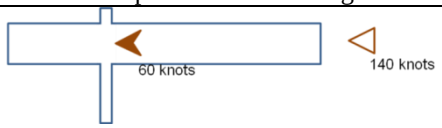
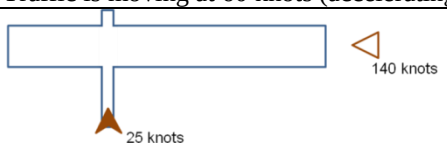
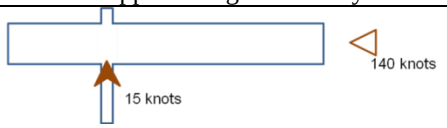
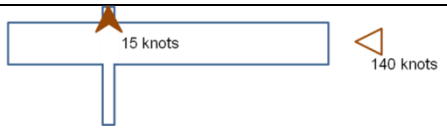
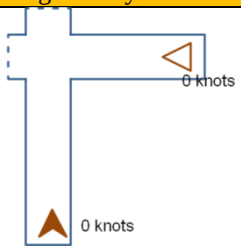
Secondary indications are provided if the runway is currently usable by ownship but there could be a potential collision hazard in the immediate future. Therefore, secondary indications are intended to increase the flight crews' situation awareness about relevant traffic that could impact the maintenance of runway safety. In that case ownship may, if appropriately cleared, proceed with taxi, take-off, or landing on the runway.

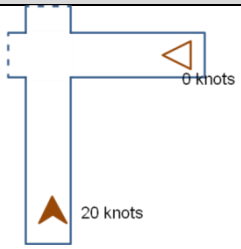
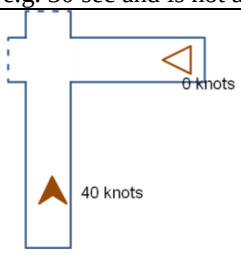
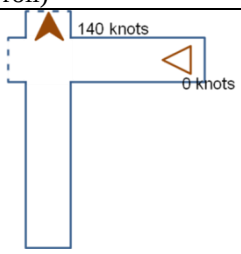
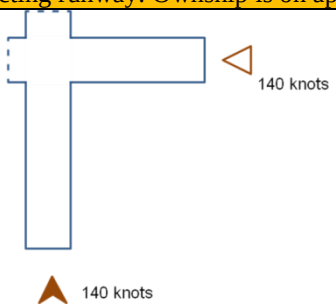
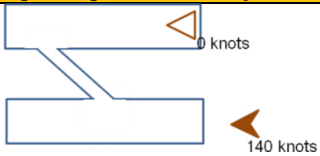
To illustrate the indication principles, examples are provided in Table 1. All numeric quantifications in that table such as distances or times, are given for illustration purposes only.

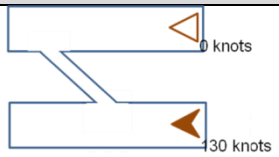
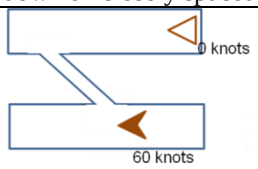
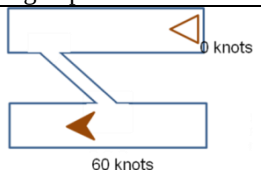
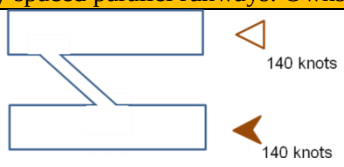
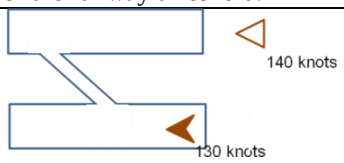
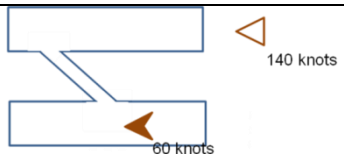
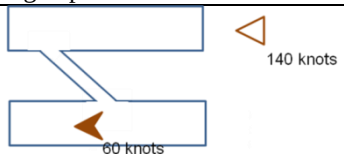
Table 1 Examples for Implementation of ATSA SURF Indication Principle

No	Example Diagram	Traffic is Relevant	ATSA SURF Indication
Ownship is taxiing on a taxiway parallel to a runway.			
1	 Traffic is further away than e.g. 1 NM from the threshold.	Yes	Secondary
2	 Traffic is within 1 NM of the threshold or on the runway.	Yes	Primary
3	 Traffic has passed ownship position.	Yes	None
Ownship is taxiing toward a runway but has not yet crossed the holdline.			
4	 Traffic is more than 1 NM away from the runway threshold	Yes	Secondary

No	Example Diagram	Traffic is Relevant	ATSA SURF Indication
5	 Traffic is less than 1 NM away from the runway threshold or is on the runway	Yes	Primary
6	 Traffic has passed ownship.	Yes	None
Ownship is stopped on a runway, e.g. in position and holding.			
7	 Traffic is approaching an intersection and has not yet crossed the holdline.	Yes	No
8	 Traffic ahead has crossed the holdline and is entering the runway.	Yes	Primary
9	 Traffic is approaching the runway threshold from behind and is less than 3 NM from the runway threshold.	Yes	Secondary
10	 Ownship is on the runway and not moving, traffic is ahead of ownship and moving away from ownship.	Yes	Primary
Ownship is taxiing on the runway			
11	 Traffic behind ownship is taxiing toward the runway but has not yet crossed the holdline.	No	None
12	 Traffic behind ownship has crossed the holdline and is taxiing perpendicular to ownship.	Yes	None

No	Example Diagram	Traffic is Relevant	ATSA SURF Indication
13	 Traffic behind ownship is taxiing into the opposite direction as ownship	Yes	None
14	 Traffic is moving toward ownship but is not converging because ownship is moving faster than the traffic.	Yes	None
15	 Traffic is moving toward ownship and is converging with ownship.	Yes	Secondary
Ownship is on approach to a runway and within 3 NM from the runway threshold.			
16	 Traffic is in position and holding on the runway.	Yes	Primary
17	 Traffic is moving at 60 knots (accelerating or decelerating) on the runway.	Yes	Primary
18	 Traffic is approaching the runway but has not yet crossed the holdline.	Yes	None
19	 Traffic is approaching the runway from a taxiway and has crossed the holdline.	Yes	Primary
20	 Traffic is exiting the runway but has not yet crossed the runway hold-line.	Yes	Primary
Intersecting runways: Ownship stopped on runway (ie. position and holding)			
21	 Traffic is stopped (position and holding)	Yes	Secondary

No	Example Diagram	Traffic is Relevant	ATSA SURF Indication
22	 Traffic is moving at 20 knots but not predicted on ownship's runway within e.g. 30 sec and is not accelerating (i.e. has NOT started take-off roll)	Yes	Secondary
23	 Traffic is moving at 40 knots and is accelerating (ie. has started take-off roll)	Yes	Primary
24	 Traffic has passed the runway intersection with ownship	Yes	None
Intersecting runway: Ownship is on approach to the runway and within 3 NM of the runway threshold.			
25	 Traffic is on approach to the intersecting runway and within 3 NM of the runway threshold and a potential conflict is predicted over the runway intersection. A potential conflict is defined as two aircraft crossing the runway intersection within e.g. 30 sec.	Yes	Secondary
Closely spaced parallel runways: Ownship is stopped on runway (ie. in position and holding).			
26	 Traffic is on approach to the closely spaced parallel runway and further away than 1 NM from the runway threshold.	Yes	None

No	Example Diagram	Traffic is Relevant	ATSA SURF Indication
27	 Traffic is closer than 1 NM from the runway threshold or has touched down on closely spaced parallel runway.	Yes	Secondary
28	 Traffic taxies at high speed on closely spaced parallel runway ahead of a high-speed intersection.	Yes	Secondary
29	 Traffic taxies at high speed on closely spaced parallel runway but is beyond high-speed taxiway leading to ownship runway.	Yes	None
Closely spaced parallel runways: Ownship is on approach to runway within 3 NM of runway threshold.			
30	 Traffic is on approach to the closely spaced parallel runway within 3 NM of the runway threshold.	Yes	Secondary
31	 Traffic has touched down on closely spaced parallel runway.	Yes	Secondary
32	 Traffic taxies at hight speed on closely spaced parallel runway ahead of a high-speed intersection.	Yes	Secondary
33	 Traffic taxies at high speed on closely spaced parallel runway but beyond high-speed taxiway leading to ownship runway.	Yes	None

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2.1.1.2 Alerting Principles

ATSA SURF alerts are intended to help prevent potential collisions between two aircraft or vehicles. ATSA SURF employs a two-level alerting scheme. The term *alert* is used in this document consistent with the regulatory guidance in draft AC 25.1322 (FAA 2007c) to describe a flight deck annunciation meant to attract the attention of the flight crew to a non-normal operational or airplane systems condition.

Whereas AC 25.1322 (FAA 2007c) defines three possible levels of alerting (advisory, caution, and warning), ATSA SURF alerts are provided only on up to two levels. This is because, first, in situations of imminent collision risk, immediate flight crew awareness and immediate flight crew response is necessary (i.e., warnings). Second, precursory caution alerts are intended to provide immediate flight crew awareness about impending collisions and thereby facilitate a timely response. Advisory alerts are not used in this concept, because in all alert cases either subsequent or immediate subsequent response is required. Instead of advisories, indications are provided, (see above).

The ATSA SURF two-level alerting scheme is similar to the two-level alerting scheme in TCAS II. Consistency between SURF ALERT and TCAS II is considered desirable due to the potentially positive transfer of experience between the systems.

Alerts are triggered dependent on scenario and are sensitive to various factors that include time to the conflict, ownship operation, movement and position of the conflict aircraft, available flight crew responses[10], as well as an acceptable degree of uncertainty[11]. Alerts are presented sequentially if more than one alert is provided in a given scenario and they follow indications that were given prior to alerts. If cautions are provided, they are provided prior to alerts. If two alerts are generated at the same time, the higher priority alert or alert with closer proximity to ownship is displayed first. The used alert levels are:

1. Cautions require immediate flight crew awareness and require subsequent flight crew response. The flight crew may not respond to the caution by a compensatory action but, for example, acquire additional information before initiating action.

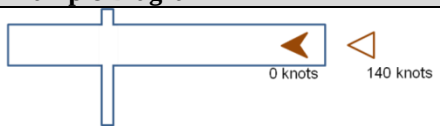
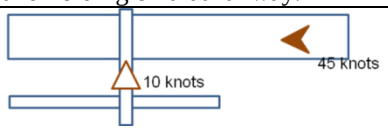
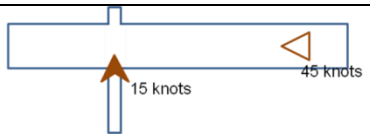
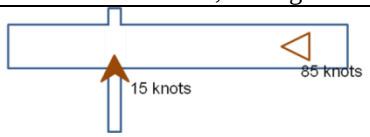
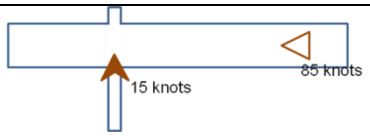
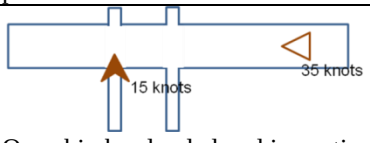
   Presentation principle: Caution alerts are presented unless they would cause unacceptable distraction during high workload and time critical situations. E.g. cautions may be suppressed when the aircraft's speed during the departure roll has reached a speed where the crew has committed to take-off (e.g. above 80 knots).

2. Warnings require immediate flight crew awareness and immediate flight crew response.

[10] If not sufficient time and distance were available for example to abort a take-off, an alert would be suppressed to not distract the flight crew.

[11] An acceptable degree of uncertainty results in sufficiently low nuisance and missed alert rates while correctly detecting alert events with appropriate latency. Determination of acceptable levels of uncertainty is a subject to research.

404 *Presentation principle: Warning alerts are presented anytime as they*
405 *are needed and are only suppressed when providing a warning is*
406 *associated with a greater hazard than the warning condition itself.*
407
408 To illustrate the alerting principles, examples are provided. All numeric quantifications such as
409 distances or speeds are given for illustration purposes only.
410
411 **Table 2 Examples for Implementation of ATSA SURF Alerting Principle.**

No	Example Diagram	ATSA SURF Alert Onset
1	 Ownship is on approach to a runway, a conflict aircraft is in position and holding on that runway.	**Caution** when ownship is within e.g. 35 sec of rwy threshold **Warning** when ownship is within e.g. 15 sec of rwy threshold
2	 Ownship has crossed a runway holdline and an aircraft is approaching that intersection	**Caution**: None **Warning**: As traffic is faster than e.g. 40 knots
3	 Ownship is on departure roll on a runway, and conflict traffic has crossed the holdline, taxiing onto the runway.	**Caution**: None **Warning**: As conflict is detected when ownship is moving at faster than e.g. 40 knots
4a	 Ownship is on landing rollout on a runway, still at high rollout speed, and conflict traffic has crossed the holdline and a conflict is predicted.	**Caution**: None **Warning**: As conflict is detected when ownship is moving at faster than 40 knots
4b	 Ownship is on landing rollout on a runway, still at high rollout speed, and conflict traffic has crossed the holdline and a conflict is **NOT** predicted.	**Caution**: As traffic is ahead of ownship on runway without predicted conflict risk **Warning**: None
4c	 Ownship has landed and is continuing to taxi at 35 knots, and conflict traffic has crossed the holdline, taxiing onto the runway.	**Caution**: As conflict is detected and ownship is moving at slower than e.g. 40 knots **Warning**: As conflict is detected within e.g. 15 sec.
5	 Ownship is in position and holding on a runway, a conflict aircraft approaches the runway from behind.	**Caution**: As conflict aircraft is within e.g. 35* sec of runway threshold **Warning**: As conflict aircraft is within e.g. 15 sec of runway threshold

Alerts are extinguished as either conditions for a higher-level alert are met or no conflict with alert traffic exist.

2.2. Procedures and responsibilities

2.2.1. Air traffic control

At towered airports, ATSA SURF IA equipped aircraft will be under control of local tower and ground controllers. Controller procedures and responsibilities will not change with this application. Air traffic controllers will continue to be responsible for managing traffic under their control to ensure safety and provide operational efficiency. In towers where ground-based runway safety surveillance and warning systems have been installed, controllers will continue to use these systems. ATSA SURF IA information is expected to supplement, not replace, existing ATC procedures and systems. Flight crews will communicate with controllers if deviating from their cleared route as they do in today's environment (e.g. communication of pilot initiated go-around). ATSA SURF alerts may cause maneuvers that will require prior or subsequent coordination with air traffic control.
ATSA SURF IAs will also be available at non-towered airports.

2.2.1.1. Proposed new pilot-controller phraseology

Current phraseology will be used for the proposed operations. No new phraseology is foreseen to be needed.

2.2.1.2. Aircraft separation / spacing criteria

There is no change in aircraft separation minima for this application.

2.2.2. Pilots

No changes in the basic responsibilities for pilots, including separation responsibility, are required. ATSA SURF IA capability status will be determined by the flight crew. ATSA SURF indications and alerts are only presented after the aircraft is in the active movement area.

ATSA SURF indications are not intended to replace ATC clearances, available outside visual references or provide exclusive aircraft navigation or guidance. ATSA SURF indications are supplemental information to outside visual references and primary means of navigation. The primary means of authorizing aircraft movement during taxi, take-off, and landing at controlled airports and airspace is by Air Traffic Control (ATC) clearance.

After an alert occurs, the flight crew shall use all available information including radio communication, outside visual references, and the ATSA SURF display to quickly assess the situation, determine the safety risk and appropriate action, and initiate the appropriate response. It needs to be determined if a subset of ATSA SURF IA alerts will provide resolution advisories.

Flight crews will be trained for mixed equipage situations where not all aircraft will be monitored by the ATSA SURF IA application. This may be either due to lack of equipage, or

inoperative equipment. As under current operations, unequipped aircraft may only be acquired visually. The flight crew continues to scan outside the cockpit as under current operations. Specifically, in mixed equipage situations, the absence of an indication or alert is no assurance that the path ahead is clear – i.e., no guarantee that there is no potential or actual traffic conflict.

2.2.3. Other Responsibilities

There are no new Airline, Flight Service Station, or other responsibilities associated with ATSA SURF IA.

3. Sample scenarios

This section contains examples for ATSA SURF indications and alerting in five incursion situations. Each scenario shows a different ownship operation: arrival, taxiing toward a runway, departure, landing, taxiing on runway.

3.1. Ownship is on approach to a runway and conflict traffic is on runway

1. Ownship is on approach to a runway on which another aircraft is in position and holding. As ownship is 3 NM away, a primary indication is displayed to the flight crew. This indicates that the runway is currently unusable. At the current display zoom setting, the runway and airport are not on the display but an off-scale traffic indication is shown. Because the crew considers this normal operations they decide to monitor the situation and continue the approach.

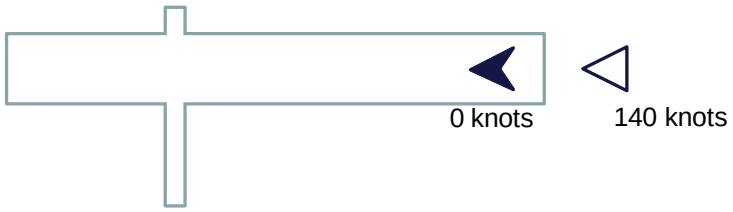


Figure 2 Ownship (outline of triangle) on approach to a runway where an aircraft is in position and holding (dark chevron). Not drawn to scale.

2. As ownship is 35 sec away from the runway threshold, the same aircraft is still in position on ownship's arrival runway. Therefore, a caution alert is presented. Upon receiving the caution alert, the flight crew gets ready for a go-around but decides to continue the approach because there is still time initiate the go-around at a later time and the aircraft seems to still have time to complete a take-off.
3. As ownship is within 15 sec from the runway threshold, the same aircraft is still in position on ownship's arrival runway. At that time the flight crew is initiating the anticipated go-around. The flight crew notifies ATC about their go-around.

3.2 Ownship is approaching a runway from a taxiway

1. Ownship is taxing on a taxiway toward a runway and has been instructed to hold-short of that runway. Visibility is below 1200 feet. An aircraft is taxiing into position and hold on that runway. Ownship is 1000 feet away from the runway center line as a secondary visual indication about runway occupancy is presented. Therefore, the flight crew becomes aware that another aircraft is on that runway but that at this point the runway could be safely crossed. The flight crew adjusts the zoom on the CDTI and finds the target symbol of the aircraft that is in position and holding on that runway.

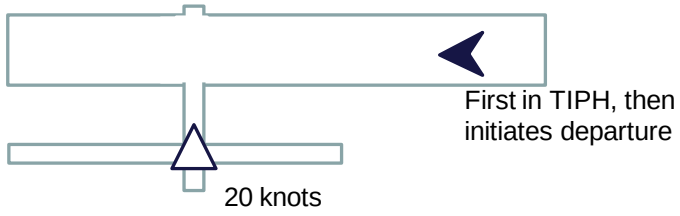


Figure 3 Ownship is approaching a runway from a taxiway while an aircraft is initially in position and holding and then departs.

2.a. Ownship continues taxiing and the conflict aircraft starts the departure roll. That aircraft is not visible to ownship out the window. A primary indication with an auditory call-out indicates the flight crew that there is high speed traffic on the runway ahead. In response ownship's crew holds short prior to the runway holdline.

2.b. In this variant of the same scenario, again, ownship taxies toward a runway and a conflict aircraft starts the departure roll. A primary indication with an auditory call-out indicates the high speed traffic on the runway ahead. However, the flight crew looks outside the window and a concurrent ATC radio call acoustically hides the auditory component of the primary indication. Therefore, the flight crew is unable to hear the callout and does not perceive the graphical depiction of primary indication on the CDTI. In addition, the flight crew mistakenly assumes that they are cleared to cross that runway (in difference to the scenario outlined in 2.a). As ownship is crossing the runway holdline, a visual and auditory warnings sounds. In response to the warning, the flight crew immediately initiates braking and stops after the holdline but prior to entering the runway itself.

3.3 Ownship is departing; another aircraft is entering ahead

1. Ownship is in position and holding on a runway, visibility is less than 1200 feet. There is no other aircraft on the runway but an aircraft is approaching that runway from a taxiway at 20 knots but has not yet crossed the holdline. No ATSA SURF indication is displayed on ownship.

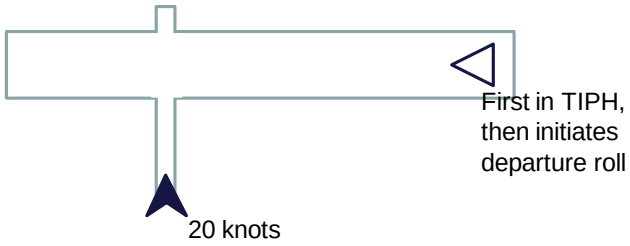


Figure 4 Ownship is in position and holding and then departing as an aircraft is about to enter the runway

2.a. Ownship is still in position and holding on runway 29. An aircraft is crossing the hold line at a speed of 10 knots. That aircraft is not visible to ownship out the window. A primary indication of runway is displayed which indicates to the flight crew that the runway is currently unusable for take-off. As ATC clears ownship for departure, the crew rejects the clearance and refers to the crossing traffic. ATC subsequently cancels the departure clearance.

2.b. In a variant of this scenarios, ownship has just initiated a take-off when an aircraft is taxiing onto the runway. Ownship's crew receives a warning as soon as the conflicting traffic has crossed the holdline. The flight crew immediately aborts the takeoff.

3.4 Ownship is landing and conflict traffic is taxiing onto the runway.

Ownship has touched down on a runway at a visibility of less than 1200 feet. The flight crew has not yet deployed spoilers or speed brakes. At this time, a conflict aircraft is crossing the holdline at a taxiway ahead and is entering the runway. That aircraft is not visible to ownship out the window. At this moment, ownship's flight crew hears a warning about the traffic ahead. The warning message contains the distance between ownship and the conflict aircraft; the flight crew determines that they are able to stop prior to that aircraft and initiates maximum braking. As the aircraft decelerates, the distance between traffic and ownship is called out in decrements of 100 feet. Ownship stops prior to the conflict aircraft.

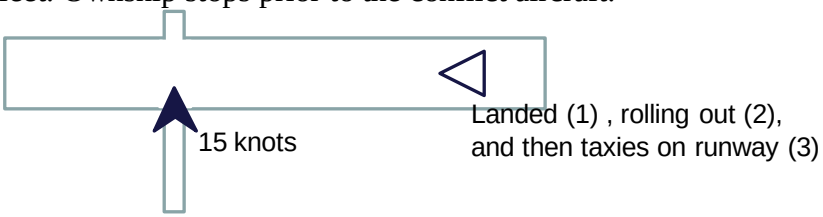


Figure 5 Ownship has landed on a runway and an aircraft is entering the runway ahead of ownship.

1. In a second variant of this scenario, ownship has landed and is rolling out on a runway at a visibility of less than 1200 feet. A conflict aircraft has just crossed the holdline at a taxiway ahead of ownship and is taxiing onto the runway. That aircraft is not visible to ownship out the window. Ownship hears a warning about the traffic ahead; the warning also contains the distance between ownship and the traffic. The flight crew initiates maximum braking. As the ownship decelerates, the warning system calls out the distance between ownship and traffic in 100 feet decrements. The flight crew uses this information

to monitor that the current deceleration will in fact allow stopping prior to the other aircraft. Finally, the flight crew acquires visual contact with the conflict aircraft and stops.

2. In a third variant of this scenario, ownship has landed, completed its roll-out and is maintaining a taxi speed of 40 knots because the crew wants to quickly reach the arrival terminal rather than taxi slowly on the taxiway. A conflict aircraft has just crossed the holdline at a taxiway ahead of ownship and is taxiing onto the runway. Ownship's flight crew hears a caution alert as they are about 15 sec away from the conflict aircraft. The flight slows down and exits the runway at an intersection prior to the conflict aircraft.

3.5 Ownship is taxiing on a runway and an aircraft is approaching from behind

1. After an erroneous turn, ownship is taxiing on a runway for which the flight crew has not received a clearance. A conflict aircraft is approaching that runway and is about 3 NM away from the runway threshold. The flight crew scans their CDTI and notices a secondary indication that highlights the approaching traffic from behind. At this point the flight crew realizes that a conflict is about to develop and therefore exits the runway.

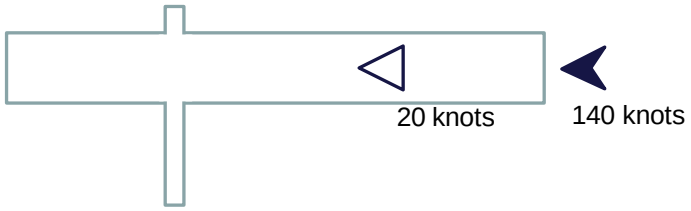


Figure 6 Ownship is taxiing on runways and an aircraft is approaching from behind.

2. In a second variant of this scenario, again, after an erroneous turn, ownship is taxiing on a runway and a conflict aircraft is approaching that runway and is about 3 NM away from the runway threshold. The flight crew focuses their attention outside the window and fails to observe the secondary indication on their CDTI that highlights the approaching traffic from behind. However, as the conflict aircraft is 35 sec from the arrival threshold, the flight crew hears a caution alert. At this point, the flight crew realizes that they are on a runway without clearance by air traffic control and that a conflict is developing from behind. They decide to accelerate their taxiing to exit the runway at the next closest intersection. In addition, the flight crew contacts the controller to indicate their presence on that runway and their intent to clear the runway at the next exit.
3. After ownship has accelerated their taxiing, they get close to reaching the next runway exit. As the conflict aircraft is 15 sec away from the arrival threshold, ownship receives a warning alert. The flight crew then even further accelerates their exit maneuver and clears the runway. At the same time the conflict aircraft has been contacted by ATC to initiate a go-around maneuver and subsequently goes around. The conflict has been resolved.

4. Requirements

4.1. Functional Performance Requirements

ATSA SURF alerts and indications need to be displayed within acceptable tolerances of missed and nuisance, and false alerts. Acceptable tolerances will be established as part of a safety analysis.

4.2. Display Requirements

The implementation of ATSA SURF IAs depends on the aircraft type specific flight deck display implementations to achieve overall consistency. There exist significant differences in how e.g. visual and auditory attention getters are utilized in different aircraft types. Therefore, the list of display requirements that is presented here (see Table 3) provides general guidance for implementation with a CDTI. Though map and traffic displays are not strictly required, they are included because this application description focuses on a CDTI implementation. Considerations for non-CDTI implementations will be part of future versions of this document.

Table 3 Presentation Requirements for Indications and Alerts and a CDTI implementation

		Indication Requirements		Alerting Requirements	
		Primary Indication	**Secondary Indication**	**Caution**	**Warning**
A combination of at least two of these feature types is required.	**Highlighting of target, e.g. color, shape, size, outline, etc.**	R	R	R (Color: Yellow/amber)	R (Color: Red)
	Highlighting of runway (if used)	R	O	R	R
	Textual Information Area (if used)	R	O	R	R
Target identification		D	D	R	R
Target ground speed		D	D	O	O
Target heading+		D	D	D	D
Distance / Time Ownship to Traffic		O	O	O	O
Target on ground / in air		D	D	D	D
Visual attention getter (e.g. flashing, Master Caution / Warning; display in primary field of view)		No	No	R	R
Auditory attention attracting, non-speech signal		No*	No	O	O
Auditory (speech) information		No*	No	R	R
Off-scale traffic position information		R	R	R	R
Ownship symbol		TBD	TBD	TBD	TBD

Notes:
R: Required for minimal implementation
D: Desired
O: Optional – depends on implementation
+ Not applicable for ground vehicles
* Except in scenarios where ownship taxies toward a runway with high speed converging traffic. In that scenario, auditory signals and auditory (speech) information are desired.

The presentation of ATSA SURF IAs should be consistent with existing traffic alerting, specifically for TCAS equipped aircraft. Therefore, TCAS alerting requirements are displayed in Table 4 as outlined in FAA (2001).

Table 4 Specification of TCAS Alerting

Ownship	Resolution Advisory (RA)	Traffic Advisory (TA)	Display Traffic
Above 1000 feet (+/- 100) AGL*	*Visual and auditory component*	*Visual and auditory component*	*Yes*
At or below 1000 feet (+/- 100) and above 500 (+/- 100) AGL	No	Visual and auditory component	Yes
At or below 500 (+/- 100)	No	Visual with**out** auditory component	Yes

*ATSA SURF IA does not provide alerts above 1000 feet AGL.

4.3. Infrastructure Requirements

4.3.1. Ground / ATC

ATSA SURF IA does not require but will utilize available ground infrastructure that provides adequate surface coverage for ADS-B dual links for Universal Access Transceivers (UAT) and Mode S extended squitters (1090ES) transponders[12]. Specifically, to increase surveillance coverage there may be a need to provide one or more ADS-B Ground Based Transceivers (GBTs) to allow communication between aircraft equipped with different radio frequency ADS-B transponders to see each other. The ADS-B surface environment is depicted in Figure 7 and consists of one or more ADS-B ground stations capable of receiving and retransmitting both 1090ES and UAT. Other surveillance sources beside ADS-B are provided as Traffic Information Service – Broadcast (TIS-B) uplink through the ADS-B ground station. The ground control facility would provide a tracker to minimize the retransmission of redundant traffic from ADS-B, radar, and multi-lateration surveillance using TIS-B. In future versions of this concept, other ground-based information such as runway closure information may be uplinked to the aircraft for processing in the on board indication and alerting logic.

At airports where the outlined ground infrastructure does not exist and where some aircraft are not ADS-B OUT equipped, the effectiveness of the alerting capability will be diminished because no indications or alerting can be provided about non- ADS-B OUT equipped aircraft.

[12] UAT and 1090ES are two different data link systems on board of aircraft to send and receive ADS-B data using different protocols and frequencies.

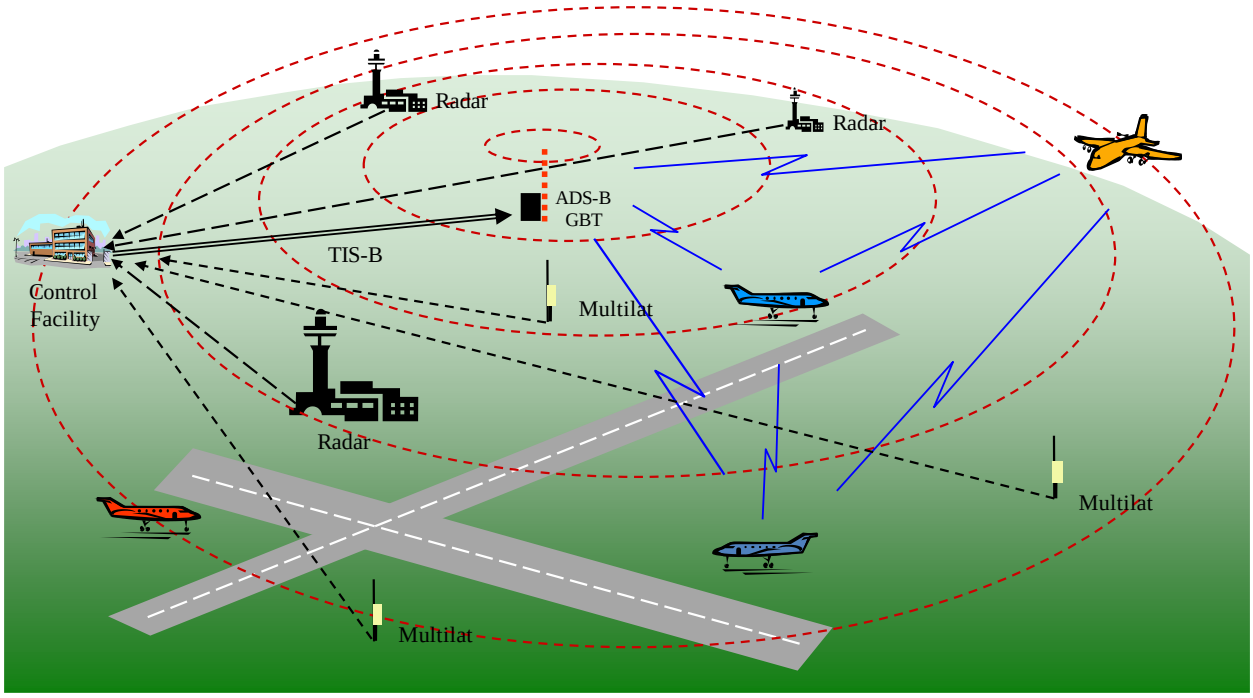


Figure 7 ADS-B Surface Environment

This configuration allows aircraft near the surface on approach or departure as well as aircraft on the airport surface to communicate via ADS-B. Ground surveillance requirements are, for example, listed in RTCA (1999).

4.3.2. Aircraft

The ATSA SURF IA capability will require the flight deck be equipped with ADS-B IN[13] and OUT[14] as defined in the FAA ADS-B surveillance requirements (FAA 2007b). This will allow the aircraft to receive ADS-B transmissions from other aircraft in the ATSA SURF IA operational area and also provide ownship position transmissions to all other local aircraft. The aircraft will also need to be equipped with a system that can host the ATSA SURF IA logic, airport surface map database and the ability to provide that information to the ATSA SURF IA logic. The ATSA SURF IA system will also provide the necessary interfaces to the aircraft audio system and to a moving map display if available. Figure 8 shows the Aircraft Surveillance Applications (ASA) systems architecture for ATSA SURF IA.

[13] ADS-B IN is considered the ability for the aircraft ADS-B system to receive and display ADS-B and TIS-B information.

[14] ADS-B OUT is considered the aircraft capability to generate and transmit industry standard ADS-B messages based on the ADS-B technology installed in the aircraft.

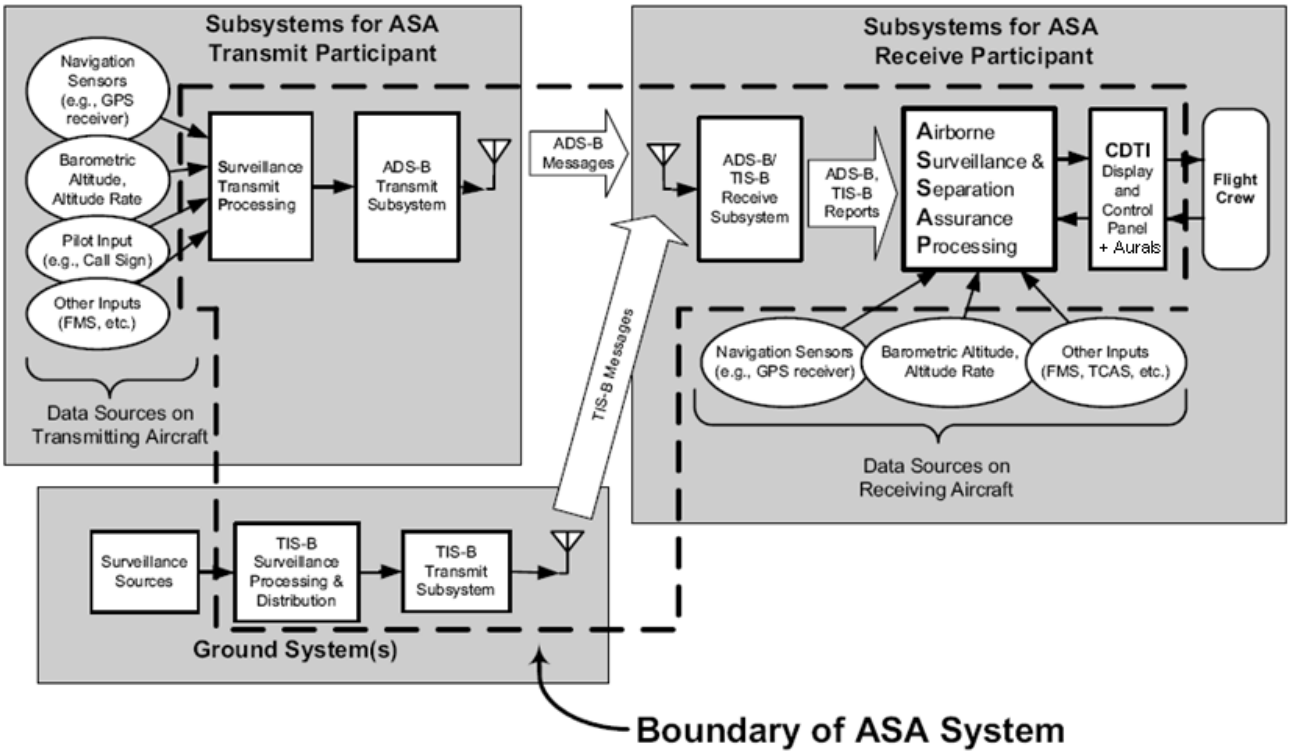


Figure 8 Example for ATSA SURF IA Systems Architecture including a CDTI Display.

Figure 8 shows a generic systems architecture for ATSA SURF IA from RTCA (2006) that includes a CDTI display. Alternative system architectures exist. In this architecture, the warning logic is a new capability and part of the Airborne Surveillance Separation Assurance Processing (ASSAP). Map and traffic displays are part of this application description because they are assumed in this application description[15]. An analysis of performance requirements will be performed to determine technical requirements for this capability.

4.3.3. Airlines Operations Center & Flight Service Stations

It is not expected that any new infrastructure is needed at Airlines Operations Centers or the Flight Service Stations to provide direct cockpit warning support.

5. Training and Maintenance requirements

TBD

6. Other Considerations

ATSA SURF IA provides traffic indications and alerts about traffic. Other runway safety risk areas exist that this application does not address. For, example ATSA SURF IA does not display deviations from controller cleared taxi routes, runway closure status, runway obstructions (e.g., construction areas or equipment), runway length limitations for take-off or landing, or usage of unauthorized runways, etc. Different indication and alerting systems are required for such indications and alerts.

[15] Considerations for non-CDTI implementations will be part of future versions of this document.

6.1. Relationship to other programs and future enhancements

TBD

6.2. Other issues

1. What auditory information should be contained in alert messages to facilitate effective flight crew responses?

    - Issue: Auditory alert information will have to facilitate immediate flight crew awareness and either subsequent or immediate flight crew response. Alerts can be directive and guide the flight crew in their response selection or be non-directive and not guide the flight crew. Advantages and disadvantages are associated with each of the alternatives.

    - Resolution Method: human in the loop simulation, analysis or performance requirements
    - Status: open
    - Resolution: TBD

2. What are acceptable rates for false and missed alerts?
    - Issue: False alerts have shown to generally decrease trust of users into their task and are associated with decreased likelihood or delay of operator response to the alert (see Bliss & Fallon, 2006). False and missed alerts may also increase the operators workload. Therefore, false and missed alerts are undesirable design features and will need to be quantified.
    - Resolution Method: Safety analysis
    - Status: open
    - Resolution: Not part of OSED tasking

3. To what extent and how should auditory information be used for ATSA SURF indications?
    - Issue: The provision of auditory information for ATSA SURF indications may result in overloading the auditory channel of pilots during normal operational conditions. However, in some situations, where surveillance quality may not be sufficient for timely alerting, indications with auditory annunciators may be the only way to provide relevant information to the flight crew. Therefore, the advantages and disadvantages of auditory annunciations accompanying ATSA SURF indications needs to be determined.
    - Resolution Method: Empirical study, group consensus
    - Status: open
    - Resolution: TBD

4. What is the appropriate principle for the presentation of indications?
    - Issue: Two principles are differentiated: a basic principle and a context dependent principle. Which of the two principles is more effective?
    - Resolution Method: Empirical study
    - Status: closed

- Resolution: The context dependent principle was found more effective. In a human in the loop simulation it was observed that the basic principle led in some situations to too many indications which in turn decreased the usefulness of indications.

5. Are ATSA SURF alerts provided to ATC?
   - Issue: An alert that is provided on the flight deck may cause the flight crew to initiate a maneuver that is unexpected by ATC, e.g. a go-around. Providing the alert automatically to ATC may provide benefits but it is not clear how this alert would be used by ATC. Is it required to downlink ATSA SURF alerts to ATC?
   - Resolution Method: Group consensus, analysis
   - Status: currently closed
   - Resolution: In the first version of ATSA SURF IA, alerts will not be provided to controllers. The OSED will not include changes in the roles and responsibilities of controllers. Flight crews will communicate their maneuvers with ATC as they do in current day operations.

6. What is the planned interaction between ATSA SURF alerts and other ground-based alerts?
   - Issue: ATSA SURF alerts and ground-based alerts may be triggered under different conditions. Therefore, the same situation may trigger ATSA SURF alerts but not other ground based safety alerts such as the ASDE-X safety logic or vice versa. This could potentially lead to an inconsistency in the tower that may be undesired.
   - Resolution Method: Group consensus, analysis
   - Status: closed
   - Resolution: The group does not see specific problems with different alerting algorithms.

7. Issues that are outside the scope of this application:

Following issues have been repeatedly discussed as part of this application development but found to be outside the initial scope of this application:

1. Alerting and indications about potential collisions in airport ramps areas.
2. Alerting and indications about potential collisions on airport taxiways.
3. Technological integration between ground based alerting logic and flight deck based alerting logic.[16]
4. Surveillance accuracy requirements will not be part of this application description but part of the performance requirements analysis.
5. Alerts and indications only account for traffic and do not consider non-traffic targets such as animals.

8. Definitions

Advisory The level of alert for conditions that require flight crew awareness and may require subsequent flight crew response. Advisories may or may not contain an auditory message. Advisories are associated with any color but red or

[16] The ATSA SURF IA application will be consistent with ground based alerting but not rely on the provision of ground based safety information as essential component.

	green and preferably not yellow/amber (FAA 2007a).
Alerts	The term alert is here used as a generic term to describe a flight deck annunciation[17], meant to attract the attention of, and identify to the flight crew a non-normal operational or airplane system condition. Warnings, Cautions, and Advisories are considered to be alerts. (FAA 2007a)
Attention Getting Cues	Perceptual signals (visual, auditory or tactile/haptic) designed to attract the flight crew's attention in order to obtain the immediate awareness about an alert condition.
Auditory signals	Are speech signals that contain human or artificial verbal signals, or non-speech signals that contain either tonal signals (single or multiple tones) or auditory icons (invoking high level of association with signal meaning)
Caution	The level of alert for conditions that require immediate flight crew awareness and subsequent flight crew response. Cautions are associated with an auditory signal and the color yellow/amber.
Collision	A contact between an aircraft and another aircraft/vehicle.
Conflict	A conflict is a condition that can lead to a high speed collision if no avoidance action is taken
Departure	An aircraft is accelerating and has reached a nominal speed, e.g. 35 knots.
Entering Runway Conflict	Entering the runway: An aircraft or vehicle is moving toward the runway, is anticipated to potentially enter the runway, and therefore causes a potential conflict.
False Alert	An incorrect or spurious alert caused by a failure of the alerting system including the sensor.
Flight Crew Response	The activity accomplished due to the presentation of an alert such as an action, decision, prioritization, search for additional information.
Indications	ATSA SURF indications are here used to identify to the flight crew a normal operational condition that could become a runway safety hazard. Indications do not actively attract attention from flight crews but provide enhanced situation relevant information to facilitate flight crew perception of potential safety hazards. Indications are not alerts.
Landing	An aircraft has touched down and is moving at a speed above taxispeed, e.g., 35 knots.

[17] The AC 25.1322 uses here the term "indication". This term is changed here to allow differentiation from the term "indication" that is here used specifically as defined above.

Master Aural Alert	An aural indication used to attract the flight crew's attention that is specific to an alert urgency level (e.g. Warning, Caution)
Master Visual Alert	A visual indication used to attract the flight crew's attention that is specific to an alert urgency level (e.g. Warning, Caution).
Missed Alert	Condition where, due to a system failure, an alert should, but is not generated.
Normal Condition	An operational condition or state within acceptably safe parameters for the prevailing environmental and traffic conditions at an airport.
Nuisance Alert	An alert generated by a system that is functioning as designed but which is inappropriate or unnecessary for the particular condition.
Potential Conflict	A potential conflict is a normal condition that can lead to a conflict.
Relevance of Traffic	Traffic that is viewed from ownship's current state is "relevant" if that traffic position, orientation, and movement leads to or could potentially lead to a runway incursion or collision within a foreseeable period of time or if it is required for the flight crew understanding of such situation.
Takeoff	See departure.
Warning	The level of alert for conditions that require immediate flight crew awareness and immediate flight crew response. Warnings are associated with an auditory signal and the color red.

9. References

Adam, G., Kelley, D., Steinbacher, J. G. (1994). Reports by Airline Pilots on Airport Surface Operations: Part 1. Identified Problems and Proposed Solutions for Surface Navigation and Communications. MITRE MTR 94W0000060.

Adam, G., Kelley, D., (1996). Reports by Airline Pilots on Airport Surface Operations: Part 2. Identified Problems and Proposed Solutions for Surface Operational Procedures and Factors Affecting Pilot Performance. MITRE MTR 94W0000060.v2.

Bales, R. A., Gilligan, M. R., & King, S. G. (1989). An Analysis of ATC-Related Runway Incursions, with Some Potential Technological Solutions. MITRE MTR-89W00021.

Bliss, J. P. & Fallon C. K. (2006). Active Warnings: False Alarms. In M. S. Wogalter (Ed.) Handbook of Warnings, pp. 231 - 242. Lawrence Erlbaum Associates: Mahwah, NJ.

Cardosi, K., & Yost, A., 2001, Controller and Pilot Error in Airport Operations: A Review of Previous Research and Analysis of Safety Data, U.S. Departure of Transportation, Federal

Aviation Administration, DOT/FAA/AR-00/51.

Cassell, R,. Evers, C., Esche, J. & Sleep (2003). Safety Benefits of PathProx – A Runway Incursion Alerting System. Proceedings of the Digital Avionics Conference 2003, V(22), 9.B.4-1 – 10.

Federal Aviation Administration's Runway Incursion Program Office (ATO-102) (1998), *1998* Airport Surface Operations Safety Action Plan to Prevent Runway Incursions and Improve Operations, U.S. Department of Transportation.

Federal Aviation Administration (2001). Air Carrier Operational Approval and Use of TCAS II. AC 120-55B. Department of Transportation, Federal Aviation Administration.

Federal Aviation Administration (2003a). Advisory Circular 120-74A Guidelines to standardize Flight Crew Procedures during Taxi Operations, Department of Transportation, Federal Aviation Administration.

Federal Aviation Administration (2003b). Advisory Circular 91-73 Single Pilot Procedures During Taxi Operations, Department of Transportation, Federal Aviation Administration.

Federal Aviation Administration (2005b). AMASS Specifications, FAA-E-2069a.

Federal Aviation Administration (2006a). *Design and Installation Details for Airport Visual Aids*, Advisory Circular 150/5340-1J.

Federal Aviation Administration (2006b). ASDE-X Interface Control Document, NAS-IC-24032410-xx.

Federal Aviation Administration (2007a). Runway Status Light Engineering Briefing 64a.

Federal Aviation Administration (2007b). Automatic Dependent Surveillance Broadcast (ADS-B) Out Performance Requirements to Support Air Traffic Control (ATC) Service, Notice of Proposed Rulemaking. Department of Transportation, RIN 2120-AI92: Washington, DC.

Federal Aviation Administration (2007c). Advisory Circular 25.1322 Flight Crew Alerting, Department of Transportation: Washington, DC.

Federal Aviation Administration (2008). Runway Safety Report. Department of Transportation: Washington, DC.

Cassell, R., Evers, C., Esche, J., & Sleep, B. (2002). NASA Runway Incursion Prevention System (RIPS) Dallas-Fort Worth Demonstration Performance Analysis. NASA / CR-2002-211677.

Hooey, B. L., Foyle, D. C., Andre, A. D., & Parke, B. (2000). Integrating datalink and cockpit display technologies into current and future taxi operations. Proceedings of the AIAA/IEEE/SAE 19th Digital Avionics System Conference, 7.D.2-1 - 7.D.2-8. Philadelphia, PA.

Hooey, B.L., Foyle, D.C. and Andre, A.D. (2000). Integration of Cockpit Displays for Surface Operations: The Final Stage of a Human-Centered Design Approach. SAE Transactions: Journal of Aerospace, 109, 1053-1065.

Hyer, P. V. (2002). Demonstration of Land and Hold Short Technology at the Dallas-Fort Worth International Airport. NASA / CR-2002-211642.

IFATCA (2003). A-SMGCS Implementation in Europe. Publication of the International Federation of Air Traffic Controllers' Associations.

Jones, D. (2002). Runway Incursion Prevention System Simulation Evaluation. Presented at the 21st Digital Avionics Systems Conference.

Jones, D. (2005). Runway incursion prevention system testing at the Wallops Flight Facility. Presented at the SPIE Defense & Security Symposium, Orlando, FL, March 28, 2005.

Jones, D. & Prinzel, L. J. (2006). Runway Incursion Prevention for General Aviation Operations. Presented at the 25th Digital Avionics Systems Conference.

Jones, D. R., Quach, C. C., & Young, S. D. (2001). Runway Incursion Prevention System – Demonstration and Testing at the Dallas/Fort Worth International Airport. Presented at the 20st Digital Avionics Systems Conference.

National Transportation Safety Board, 2000, Safety Recommendation to the FAA, A-00-66, Washington, DC.

RFG (2006). Enhanced Traffic Situational Awareness on the Airport Surface (ATSA-SURF).RFG internal document v. 1.9.

RTCA (1999). The Role of GNSS in Supporting Airport Surface Operations. Document Number RTCA/DO-247. RTCA: Washington DC.

RTCA (2003). Minimum Aviation System Performance Standards for Aircraft Surveillance Applications (ASA), DO-289. RTCA: Washington DC.

Steinbacher J. G. (1991) An Analysis of ATC-Related Runway Incursions in the National Airspace. MITRE WP 91W00234.

Young, S. D. & Jones, D. R. (2000). Runway Incursion Prevention Using an Advanced Surface Movement Guidance and Control System (A-SMGCS). Presented at the 19th Digital Avionics Systems Conference.

Young, S. D.; and Jones, D. R. (2001): Runway Incursion Prevention: A Technology Solution. Proceedings of the Flight Safety Foundation 54th Annual International Air Safety Seminar, Athens, Greece, Nov. 5 – 8, 2001.

10. Acronyms

AC	Advisory Circular
ADS-B	Automatic Dependent Surveillance – Broadcast
AGL	Above Ground Level
AMASS	Airport Movement Area Safety System
ASDE-X	Airport Surface Detection Equipment – Model X
ASSA	Airport Surface Situational Awareness
ASA	Aircraft Surveillance Application
ATC	Air Traffic Control
ATSA SURF IA	Enhanced Traffic Situational Awareness on the Airport Surface with Indications and Alerts
CDTI	Cockpit Display of Traffic Information
DFW	Dallas - Fort Worth International Airport
DVD	Digital Versatile Disc
EAT	End-around Taxiway
EUROCAE	European Organization for Civil Aviation Equipment
FAA	Federal Aviation Administration
FY	Fiscal Year
GBT	Ground Based Transceiver
GPS	Global Positioning System
FAROA	Final Approach and Runway Occupancy Awareness
ICAO	International Civil Aviation Organization
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NTSB	National Transportation Safety Board
REL	Runway Entrance Lights
RFG	Requirements Focus Group
RA	Resolution Advisory
RI	Runway Incursion
RIIEP	Runway Incursion Information Evaluation Program
RTCA	Radio Technical Commission for Aeronautics (as introuced in 1935)
SAN	San Diego International Airport
SC	Special Committee
TA	Traffic Advisory
TCAS	Traffic Alert and Collision Avoidance System
THL	Take-off Hold Lights
TIS-B	Traffic Information Service - Broadcast
UAT	Universal Access Transceiver
US	United States